MEM30031A
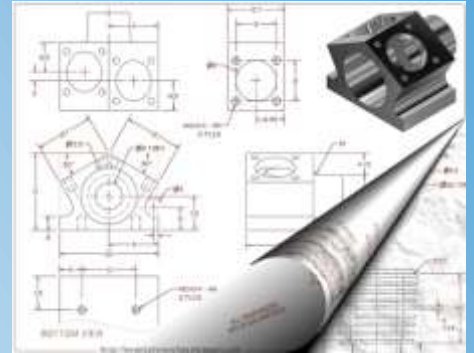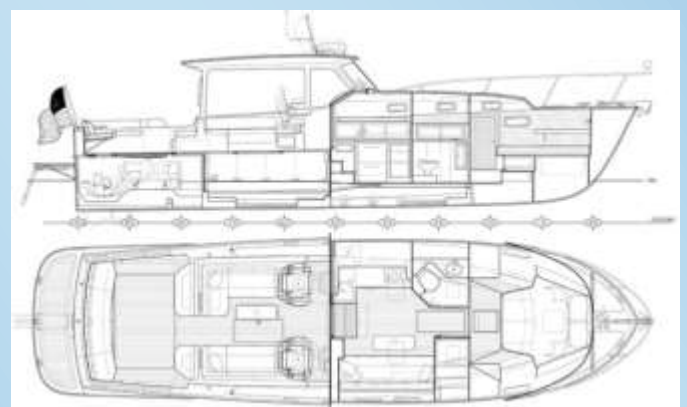
Operate computer-aided design (CAD) system to produce basic drawing elements.

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Unit Resource Manual

Manufacturing Skills Australia Courses

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Aims of the Competency Unit:

This unit of competency covers the skills and knowledge required to apply functions of computer-aided design (CAD) software programs that are typically used in the production of detail drawings.

The unit is suitable for those working within a CAD or drafting work environment and may be applied across engineering and manufacturing environments. It covers competent use of a CAD program to perform basic drawing tasks used in the development of detail drawings. Drawings may include plans, diagrams, charts, circuits, systems or schematics.

This unit includes using computer equipment and selecting software functions in order to generate basic drawing elements.

Unit Hours:
54 Hours

Prerequisites:
No prerequisite units are required for this unit however it is advisable to have achieved competency in the following:

MEM30001A   Use computer aided drafting systems to produce basic engineering drawings

Elements and Performance Criteria

1.	Determine drawing requirements	1.1	Confirm purpose, scope, and information and presentation requirements for drawing
		1.2	Review available information relevant to project and work requirements, and identify and address further information needs
		1.3	Identify computing equipment and software used in the organisation
		1.4	Identify work flow and procedures for work supervision
		1.5	Examine requirements for presentation of drawings
2	Identify key features of CAD software	2.1	Describe types of CAD software used for detail drafting, their key features and suitability for producing specific drawing outcomes
		2.2	Describe types of CAD software used for design drafting, their key features and suitability for producing specific drawing outcomes
		2.3	Identify differences in CAD process to generate 2-D drawings and 3-D models, and reasons for each presentation
		2.4	Identify differences in CAD process to generate single and multiple view drawings, and reasons for each presentation
		2.5	Identify CAD software used in the organisation and confirm compatibility with other software programs and peripheral equipment
		2.6	Identify software features for linked specifications, catalogues or materials ordering
3	Access software and set up for drawing work	3.1	Open software and navigate organisational filing and library system
		3.2	Identify organisational and software templates and determine uses
		3.3	Identify organisational symbols, codes and standards to be applied in drafting work and how these are accessed and applied
		3.4	Apply workplace procedures to retrieve and manipulate required information and navigate computing technology
		3.5	Set up working environment
4	Produce basic drawing elements	4.1	Use CAD functions to produce basic drawing elements
		4.2	Use editing and transfer tools and methods to modify drawing elements

		4.3	Apply dimensions, text and symbols to drawing elements
		4.4	Import and export files into/out of working space
		4.5	Generate different views and perspectives
		4.6	Organise presentation of work
5	Complete CAD operations	5.1	Save and file drawing elements according to organisational procedures
		5.2	Print drawing elements and evaluate presentation
		5.3	Evaluate work and identify areas for improvement
		5.4	Close applications, perform CAD housekeeping and maintain organisational filing system

Required Skills and Knowledge
Required skills include:

- literacy skills sufficient to read instructions for drawings work
- using computer technologies and navigating software
- numeracy skills sufficient to interpret technical information and determine scaling and layout issues
- navigating software to:
    - manipulate drawing entities
    - modify dimension styles
    - create and use layers
    - manipulate the drawing origin
    - define and utilise symbol libraries
    - utilise grids/grid snaps and object snaps
    - display views at multiple scales
    - add title blocks/frame to layout a drawing for printing
    - prepare advanced drawings in plane orthogonal or equivalent
    - set up prototype drawings
    - define and extract attribute data
    - create bills of materials (BOM) utilising attribute data and third-party application software

Required knowledge includes:

- general knowledge of different approaches to drawing
- awareness of copyright and intellectual property issues and legislation in relation to drawing
- environmental and occupational health and safety (OHS) issues associated with the tools and materials used for drawing
- quality assurance procedures
- CAD program capabilities and processes

Topic Program:

Topics	Skill Practice Exercises
Topic 1 – Types of CAD Software:	MEM30031-SP-0101 to MEM30031-SP-0106
Topic 2 – Template Drawings and Options:	MEM30031-SP-0201 to MEM30031-SP-0210
Topic 3 – Text Styles:	MEM30031-SP-0301 to MEM30031-SP-0305
Topic 4 – Dimension Styles:	MEM30031-SP-0401 to MEM30031-SP-0406
Topic 5 – Blocks, WBlocks, X-Refs & Insert:	MEM30031-SP-0501 to MEM30031-SP-0503
Topic 6 – Define & Insert Attributes:	MEM30031-SP-0601 to MEM30031-SP-0604
Topic 7 – Extract Attributes:	MEM30031-SP-0701 to MEM30031-SP-0706
Topic 8 – Polylines, Splines & Donuts:	MEM30031-SP-0801 to MEM30031-SP-0806
Topic 9 – Multi View Drawings:	MEM30031-SP-0901 to MEM30031-SP-0906
Topic 10 – Isometric Drawings:	MEM30031-SP-1001 to MEM30031-SP-1006
Topic 11 – Dimensioning Isometric Drawings:	MEM30031-SP-1101 to MEM30031-SP-1105
Topic 12 – User Co-ordinate System:	MEM30031-SP-1201 to MEM30031-SP-1105
Practice Competency Test	MEM30031-PT-01

Free Software Download Sites

The follow site allows their software to be downloaded, installed and used free of charge.

AutoCAD

www.students.autodesk.com

To download the latest AutoCAD or any other Autodesk software free of charge, you have to register as a student. Click on **Register** and complete your details on the following screens using your TAFE email address which is shown on your TAFE receipt when paying your fees; you may need to enquire at your TAFE Library or Administration Centre for your password.

Once registered, you can start to download any of 30 programs. Download the version you will be using in class to avoid the problems of opening and saving your drawings as versions.

On downloading the program, make a note of the Product Key and Serial Number which are required to register the software.

The software is licensed for 13 months for educational purposes ONLY. At the end of the licence period the software will not operate however the latest version can then be downloaded and installed on the same, or a new computer.

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W.H.S. ISSUES:

Workplace Health and Safety is an important workplace issue; each year thousands of workers suffer injuries that can be eliminated by adhering to basic good working practices and postures. The main injuries that can occur while working at a computer are repetitive strain injuries sustained maintaining the same position for hours on end without taking breaks or stretching. Other injuries occur through not sitting correctly on chairs and eyestrain.

⚠️ The main rule is "*TAKE SHORT BREAKS and STRETCH OFTEN*".

Step 1 - The Chair for Computer Operation

It is essential to have a suitable chair when drafting and it should possess the features depicted in the diagram.

Adjust the backrest up and down so that it fits into the small of the back. Lean against the backrest until your

back is at least 90° to your legs, although a slightly more open posture is better, up to 10° more (100°). Tilting the seat-pan a fraction downward helps give the body a slightly more open posture and relieves pressure on the lower back.

⚠️ *THE BACKREST SUPPORTS THE BACK AND IS NOT A LOUNGE*

Step 2 - Organising Your Work-Space:

Organise your work-space so that the most commonly used items are closest to you and the less used items are further away, because the further you reach out, the more strain you place on your body. Wherever possible avoid twisting of the head and torso.

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Step 3 - Eye Basics:

The eye problems experienced by draftspersons are sharp and dull pains, dry or watering eyes, burning sensations, tightness, tiredness, headaches, and other forms of discomfort, which can all be called "eyestrain". The eyestrain that most people suffer from can be as a result of a number of factors, and in the vast majority of cases, it is only a temporary situation and can be rectified by wearing prescription glasses.

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Direct Glare:

Caused by overhead lights and lamps shining directly into your eyes. Direct glare can also be a problem when a computer is positioned directly in front of a window. To find out whether direct glare is a problem, temporarily shield the light source and you will immediately notice the difference.

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Indirect or Reflected Glare:

Caused by light deflecting off surfaces and into your eyes. Objects and walls in glossy dark colours or shiny metal surfaces even as small as your watch face can cause this. Indirect glare is unlikely do you any permanent harm, but can certainly be very annoying.

Bifocal Glasses:

If you wear bifocal glasses, you may find that you are tilting your head backward in order to see the drawing, this places strain on the neck and shoulders and should be avoided. Bifocals are designed for reading, not drafting work and you should see your optometrist about options available to you.

Step 4 – Exercises:

Exercising is one of the most effective ways of reducing muscle fatigue and the possibility of injury occurrence when drafting. Warm-up exercises prepare your body for your next period of work, and micro-breaks keep the body loose, however there are rules to exercising which are:

- Never stretch to the point where you feel pain.

- If you have a medical condition or are undergoing any type of medical treatment, you must consult your medical practitioner before doing any of these exercises.

- Always apply a slow and gentle stretching action.

Exercise 1:

Bend your wrist and fingers with your other hand, bending your elbow slightly at the same time, until you feel the stretch over the back of your forearm. Hold the position for 30 seconds.

Exercise 2:

Stretch your arm out in front of you with your elbow straight, palm facing away from you (fingers pointing up or down). With your other hand pull your fingers backward until your feel the stretch over the front of your forearm. Hold the position for 30 seconds.

Exercise 3:

Tuck your chin down onto your chest and gently turn your head from side to side, keeping your chin on your chest. Do this ten times.

Exercise 4:

Turn your head slowly from side to side ten times.

Step 4 – Micro-Breaks:

Micro-breaks are rest pauses and exercises that can be done while you are at your computer workstation. These can be done to prevent your body from becoming fatigued during your working day. A good way to apply these Micro-break exercises is to follow the "30/30/30" rule, which is: Every 30 minutes, take a 30-second break, and look at an object 30 metres away and while doing this, do one or more of the following exercises

Exercise 1 – Tall Stretch:

Interlock fingers, palms up. Stretch arms above the head until they are straight. Do not arch the back.

Exercise 2 – Shoulder Roll:

Highly Recommended.

Roll the shoulders - raise them, pull them back, then drop them and relax. Repeat in the opposite direction.

Exercise 3 – Side Stretch:

Drop left shoulder, reaching left hand towards the floor. Return to starting position. Repeat on right side.

Exercise 4 – Back Curl:

Grasp shin, lift leg off the floor, bend forward curling the back, with nose towards the knee. Note: This exercise should not be used in pre-post-natal conditions.

The following Internet sites are recommended for further information:

Work Cover New South Wales

http://www.workcover.nsw.gov.au/

National Health and Safety Commission

http://www.nohsc.gov.au/

National Safety Council of Australia

http://www.safetynews.com/default.asp

Topic 1 – Types of CAD Software:

Required Skills:

On completion of the session, the participants will be able to:

- Access the AutoCAD program.
- Exit the software program and closedown the computer

Required Knowledge:

- General knowledge of different approaches to drawing.
- Name of the Absolute, Relative and Polar co-ordinate methods used in producing lines and entities.

What is CAD?

The letters CAD stand for computer-aided design. Architects, drafters, engineers, and artists use CAD software to create plans and construction drawings. Before the age of computers, drawings and blueprints were drafted by hand. CAD is more efficient because the software records lines as vectors based on mathematical equations. Portions of a drawing can be twisted, stretched, or moved with the picture as a whole automatically adjusting. CAD may also be referred to as CADD, which stands for Computer-Aided Design & Drafting.

CAD Software will let the designer:
- Switch between two-dimensional (2D) and three-dimensional (3D) views.
- Zoom in and out for close-up and distant views.
- Rotate 3D images to view them from different perspectives.
- Change the scale of images; when one value changes, related values are automatically adjusted.
- Manipulate the shape of images; changing one portion of an image automatically changes the entire picture.

History:

Computer-aided design (CAD) and the related computer-aided manufacturing (CAM) were both originally developed in the 1960s. Since its origins, CAD allowed a significant reduction in the time and cost of producing new products by allowing engineers to directly produce mechanical drawings themselves, by allowing production of complex shapes to be tested in software and by allowing the rapid development of new assembly lines.   Although the CAD software allowed the engineers to produce drawings, draftspersons were still required to produce the final detail and assembly drawings to Australians Standards.

Types of CAD Software:

CAD is used during all phases of a product's life cycle from the initial design to decommissioning. At the simplest, CAD replaces the functions of the drafting machine, pens and pencils and allows detailed drawings to be created at ease without the need for pre-planning the scale, number and arrangement of views. At the most complex, CAD output can be connected directly to machines which form final components, or to stereo lithographic machines (3D Printers) which build parts out of plastic polymers.

A considerable variety of different CAD software packages are publically available for corporate, educational, and private and target Building Design, Architecture, Structural Detailing, Home Design, Town Planning, Landscape Architecture, Landscape Design, Surveying, Garden Design, Interior Design & Fitout, Set/Stage & Expo Design, Furniture Design, Kitchen & Bathroom, Industrial & Product Design, Mechanical Engineering, Naval

Architecture, Electrical Engineering, Manufacturing CAD/CAM, Graphics & Illustration, Special Purposes, General 2D & 3D, and File Viewing & Sharing.

CAD software used in the mentioned drafting disciplines can be broken into architectural, engineering and construction. Architectural CAD software is targeted toward producing architectural drawings of buildings, living and working spaces. Construction CAD software is targeted toward construction of new buildings or renovation of old buildings, and expands upon architectural CAD software by including lists of materials needed, and other information vital to the process of completing a building. Engineering CAD software is targeted toward developing new machines and vehicles. Included in different engineering CAD software packages is not only an understanding of the strength of materials used, but also methods of determining heat flows, stresses and other qualities of materials necessary to the successful construction of new machinery.

Using most CAD software requires a good knowledge of mathematics and engineering. While there are many architectural CAD software programs designed to be used by the average Do-It-Yourself user, it could be confusing to those who are not comfortably doing their own construction.

Benefits & Misconceptions:

CAD software allows designs to be completed more quickly, evaluations of new products to be made more rapidly, and generally decreases the time-to-market of mechanisms large and small. Industry specific CAD software has allowed industry to move more quickly in designing, developing and deploying new products in all ranges of commerce.

As the price of CAD software continues to plummet, and as the realm of rapid prototyping moves from the very expensive high-end down to the Do-It-Yourself level, it may soon be that individuals at home can design, develop and produce their own unique products for sale around the world, especially with the improvement of modelling polymers and 3D printers.

As CAD software continues to grow in use and decrease in price, its availability increases, potentially allowing any interested person to use it profitably.

Using CAD software requires weeks of learning and a strong interest in engineering and mathematics.

Like all software, CAD software is only as good as the people using it; it is possible to make massive mistakes without a detailed understanding of the real world in which a CAD design will exist; especially when converting a 2D profile into a 3D object.

Types of CAD Software:

There is a lot of CAD software available nowadays ranging from free to very expensive, and price alone should not be used to determine quality.

The following list of CAD software programs are some of the most popular software programs available and are widely used by design, construction and manufacturing firms all over the world, but can also be used by everyday consumers and students after some training.

Archicad:

ArchiCAD is a 3D modeling and CAD application which allows an operator to draw, model and display building designs simply and quickly. ArchiCAD is object oriented, which means that it enables the generation and modification three dimensional objects, not just lines, and produces 2D architectural drawings and 3D models of buildings. ArchiCAD combines a variety of tools, with which can be selected, configured to form different building objects such as slabs, walls, doors, windows and roofs, to construct a virtual building.   ArchiCAD is very useful when designing, for producing simple 3D models that

are easy to modify; this enables the visualisation and testing of ideas more rapidly than by building a physical model, and more thoroughly than by drawing sketches.

Autodesk:

Autodesk is an American multinational software corporation that focuses on 2D and 3D design software for use in the architecture, engineering, construction, manufacturing, media and entertainment industries. Free software packages can be downloaded and used for educational use from the Autodesk Student Community. The main software available through Autodesk are AutoCAD, Inventor, Revit and AutoSketch.

AutoCAD:

AutoCAD is specifically designed for 2D drafting but has 3D Wireframe and Solid Modelling capabilities although specific 3D Modelling packages are far superior. The AutoCAD LT version is a low-cost program with reduced capabilities mainly in the 3D area.

Inventor:

Inventor is 3D mechanical solid modelling design software used to create 3D digital prototypes. It is used for 3D mechanical design, design communication, tooling creation and product simulation; the software enables users to produce accurate 3D models to aid in designing, visualizing and simulating products before they are built. The assembled components can be animated to visualise the assembly in the working mode and indicates any collision between the moving parts. Finite Element Analysis can be applied to determine the strength of individual components.

Revit:

Revit is a software package designed for use in the construction industry and empowers design and construction professionals to bring ideas from concept to construction with a co-ordinated and consistent model-based approach. Revit features parametrics with bi-directional assembly and linking to Mechanical, Electrical & Plumbing systems contained within the building.

MicroStation:

MicroStation is a suite of CAD software products for 2D and 3D design and drafting from Bentley Systems and is the second largest CAD package on the market today. It's the single largest competitor for AutoCAD and it holds a large share of public transit and infrastructure market. MicroStation is a fully developed drafting package that does everything its competitors can do but it has something of a reputation of being difficult to work with; a view by drafters that isn't entirely warranted, MicroStation is a user-friendly package but its problem lies in its decision to do everything differently than their larger competitor.

SolidWorks:

SolidWorks is a geometric modelling based program, and utilizes a parametric feature based approach to creating models and assemblies. SolidWorks is a very complex system, with extensive parametric design capabilities and parts cataloguing, costing, and tolerance controls while the user interface is simple and dynamic.

It provides only the needed level of complexity for a design and keeps all its tools in a tightly integrated user-friendly heads-up display. The same editing tools are applicable for both complex and simple designs; the approach, positions SolidWorks as a design package for users at all levels. The program is available in three levels, Standard, Professional and Premium.

The Standard package provides 3D design solutions for rapid creation of parts, assemblies, and 2D drawings. Application-specific tools for sheet metal, weldments, surfacing, and mould tool and die make it easy to deliver best-in-class designs.

The Professional package builds on the capabilities of SolidWorks Standard to increase design productivity, with file management tools, advanced photorealistic rendering,

automated cost estimation, professional collaboration capabilities, automated design and drawing checking, and a sophisticated components and parts library.

The Premium package is a comprehensive 3D design solution that adds powerful simulation and design validation to the capabilities of SolidWorks Professional, as well as ECAD/MCAD collaboration, reverse engineering, and advanced wire and pipe routing functionality.

Solid Edge

Solid Edge is a 3D CAD parametric feature solid modeling software operating on Microsoft Windows and provides solid modeling, assembly modelling and drafting functionality for mechanical engineers, designers and drafters. Through third party applications it has links to many other Product Lifecycle Management (PLM) technologies.

Solid Edge is a mechanical design system with tools for creating and managing 3D digital prototypes. Solid Edge assists projects towards accurate design solutions based on core modelling and process workflows, a focus on the needs of specific industries, and fully integrated design management. The Solid Edge modelling and assembly tools enable engineering teams to develop a full range of products, from single parts to assemblies containing multiple components.

TurboCAD:

TurboCAD is a top ecconomical CAD software program for 2D and 3D design and drafting which runs on Macintosh and Microsoft Windows operating systems. The Microsoft windows packages are available in Basic and Platinum editions. The Mac packages are built on a separate codebase and are not directly comparable with the Windows versions. TurboCAD Mac Pro contains both 2D and 3D tools, while the standard version is for 2D drafting only.

AutoCAD:

Although there are many different types of CAD software available, AutoCAD is currently the most popular used in industry and is also used in the majority of state sponsored educational institutions and private Registered Training Organisations (RTO's). For this reason, the notes for this Unit of Competency will focus on the AutoCAD software.

AutoCAD is a 2D and 3D computer-aided drafting software application used in architecture, construction and manufacturing to assist in the preparation of blueprints and other engineering plans. Professionals who use AutoCAD are often referred to as drafters, and while drafters work in a number of specialties, the six most common specialization areas are mechanical drafting, architectural drafting, civil drafting, electrical drafting, electronics drafting and aeronautical drafting.

AutoCAD works using Vector graphics rather than Raster graphics.

Vector graphics use geometrical formulas to represent images by specifying a point using a distance from a datum point along horizontal and vertical axes.   Vector oriented images are more flexible than raster images because they can be resized and stretched. The various CAD software programs save their drawing files with specific file extensions.

- AutoCAD   .DWG
- TurboCAD   .TCW
- Solid Edge   .ASM
- Microstation   .DGN

A computer produced drawing is a raster image is a representation, consisting of rows and columns of dots that form a graphics image in the memory of the computer. The value of each dot (whether it is filled in or not) is stored in one or more "bits" of data. For simple monochrome images, one bit is sufficient to represent each dot, but for colours and shades of grey, each dot requires more than one bit of data. The more bits used to represent a dot, the more colours and shades of grey that can be represented. Raster images are saved with .BMP, .JPG, .PNG, .GIF or similar file extensions.

Accessing the AutoCAD Program:

The method for accessing the program depends on the version installed and the installation set up. AutoCAD can be started by clicking on the Windows **Start** button at the bottom left corner of the screen, moving the mouse to **All Programs** then clicking on **Autodesk,** then **AutoCAD** and then **AutoCAD** (the word AutoCAD may be followed by the version or year). The program can also be started from the Desktop by double clicking on the AutoCAD icon if displayed.

On entering the program, a clear graphics screen is displayed with the environment displayed as set by the previous operator; the environment can be customised to suit the individual user. A typical AutoCAD environment is shown in Figure 1.1 below.

Figure 1.1

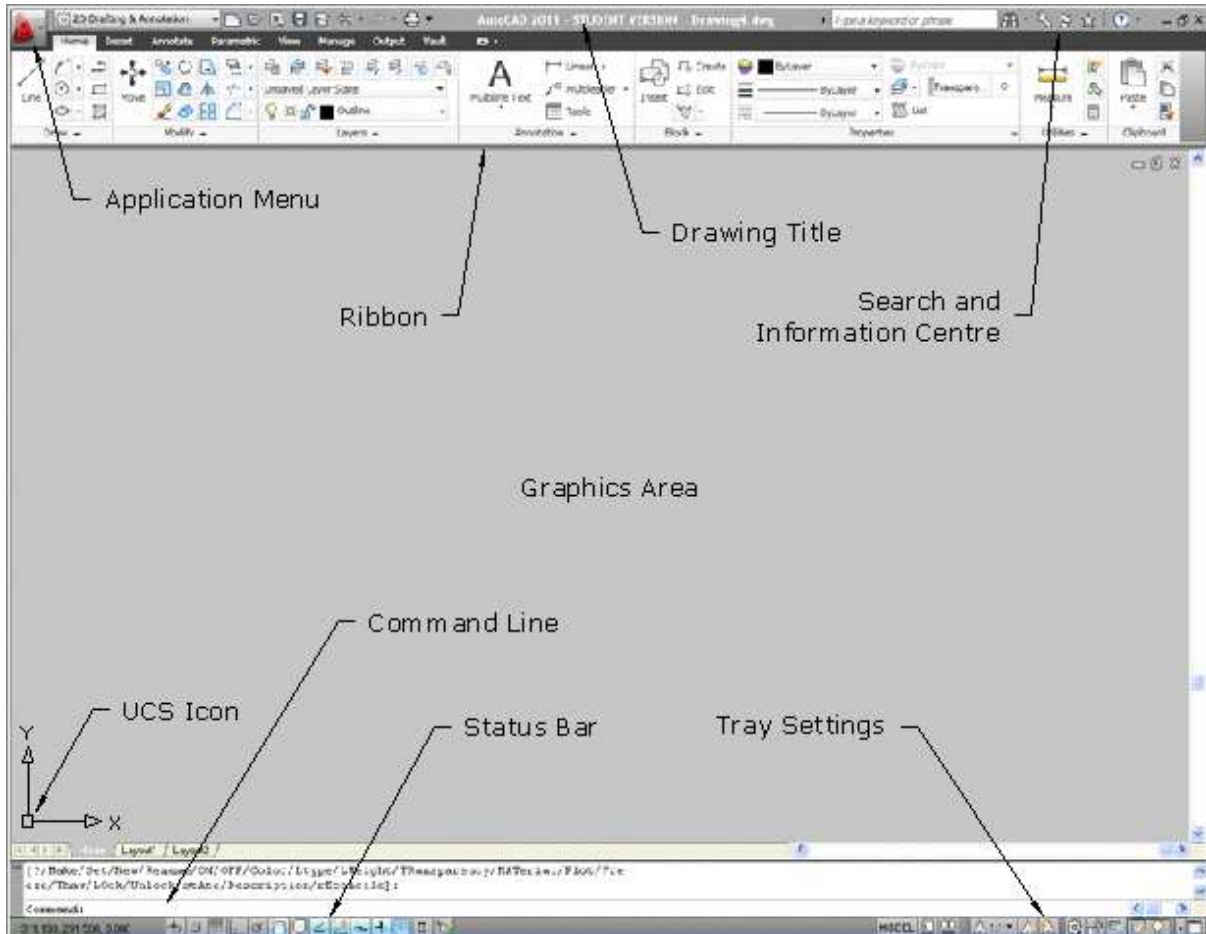The interface can also be displayed showing the standard AutoCAD Toolbar menus that can be moved between and docked onto the horizontal and vertical edges of the graphics area as shown in Figure 1.2. Using toolbar menus and docking them to the left and/or right vertical edges of the graphics area can provide a drawing area in proportion with the standard sheet sizes, especially on wide screen monitors.
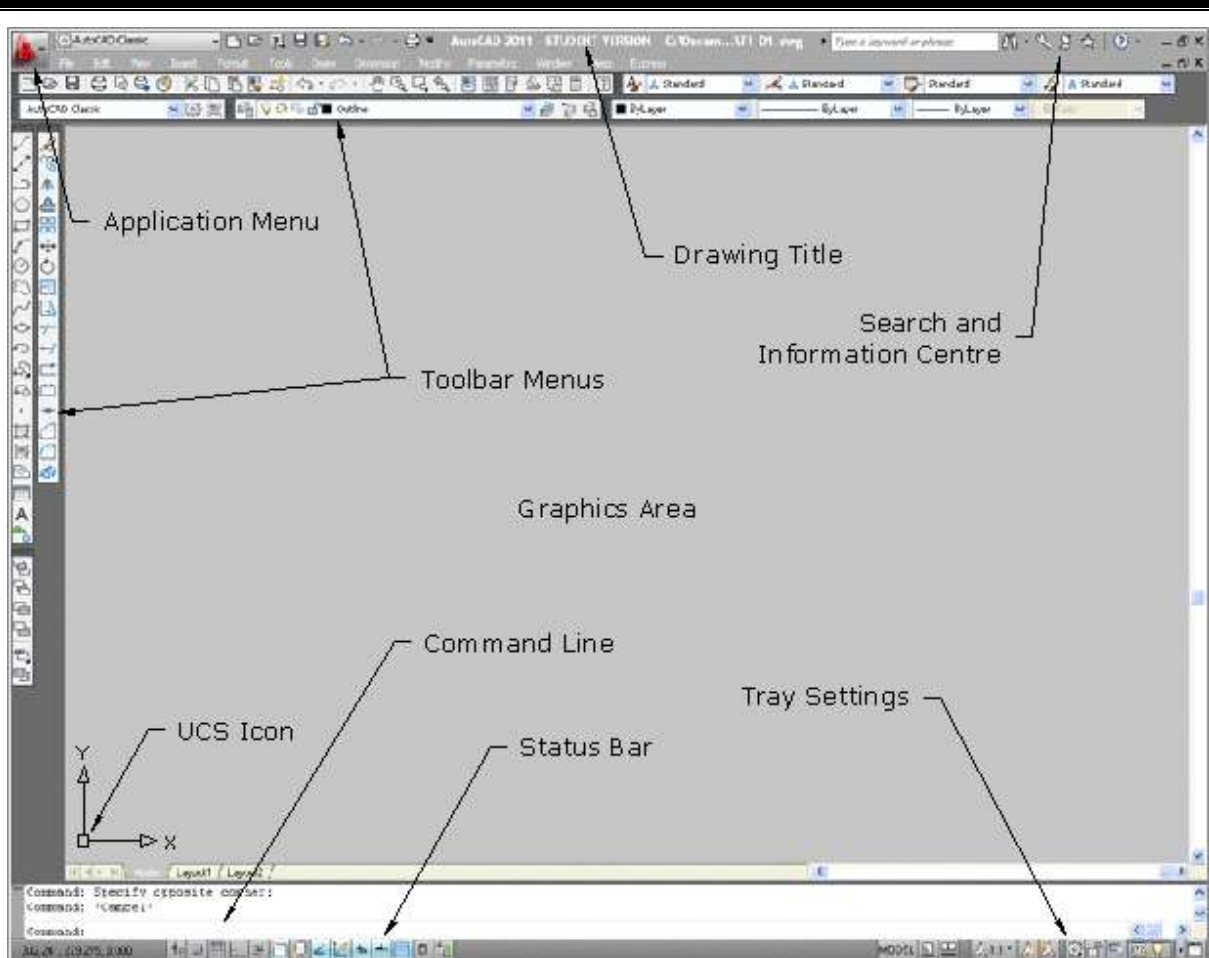
Lesson 1 – Types of CAD Software

Figure 1.2

Application Menu:

The Application menuis located in the top left corner and is used to access commands and options. The Browser appears as a drop-down menu with the File, Edit, View, Insert, Format, Tools, Draw, Dimension, Modify, Express, Window and Help menus displayed. A list of the most recently opened drawings is located in the right side column.

Ribbon:

The ribbon provides a single, compact placement for operations that are relevant to the current workspace and eliminates the need to display multiple toolbars, reducing clutter in the application and maximizing the area available for work using a single compact interface. The ribbon is similar to the Dashboard in previous releases of AutoCAD and reduces the number of toolbars therefore allowing a larger area graphics area for drawing.

The ribbon contains a series of tabs each with separate panels; these tabs include Home, Insert, Annotate, Parametric, View, Manage, Output and Vault.the main tabs are Home, Blocks and References, Annotate Tools, View, Output and Vault. Clicking on a tab displays the panels within that tab and provides the access to the different commands.

The display of the Ribbon Panel is controlled by:

Tray Settings   - *Select option from the Context Menu*.

Application Menu   A – Tools - ▷ Palettes - Ribbon

Many Ribbon tabs can be temporarily expanded to display additional commands and icons by clicking on the triangle ◢ at the bottom-right edge of the tab name. The tab can also has on option of locked open by clicking the pin also located at the bottom-right edge of the tab name.

Toolbar Menus:

Toolbar menus contain icons that activate commands.   If the cursor is placed over an icon, the name of the icon will be displayed.   Icons displaying a small triangle in the lower right corner indicated a flyout toolbar (display additional icons).   Additional toolbars can be turned on and/or off using the Top Pull Down men - View – Toolbars or right clicking over one of the displayed toolbars and selecting one of the options available.   The toolbars can be fixed to the sides of the screen or allowed to "float" about the screen by holding the left button down over a part of the toolbar (not an icon) and dragging the cursor about the screen.   Commands are executed by left clicking on the required icon.

Command Line:

Commands can be entered using the keyboard and appear in the command line.   The computer uses the command line to request further information from the operator and give instructions for the completion of the command.   The use of keyboard commands in modern CAD programs is rapidly disappearing; **get used to using the Toolbar menus**. Most mistakes are made by operators **NOT** reading the Command Line or the Dynamic Input display next to the cursor – **constantly LOOK at the Command Line** or the **Dynamic Input display**.   Commands are executed by typing the name of the command then pressing the **Enter** key.   Many commands like Erase have shortcut keys where the letter **E** can be typed then the **Enter** key or **Space** bar pressed to execute the command.

Status Bar:

The status bar displays and enables the operator to change several important settings that affect the methods of drawing and editing the current drawing. All features within the Status Bar can be turned ON and OFF by clicking on the respective button.
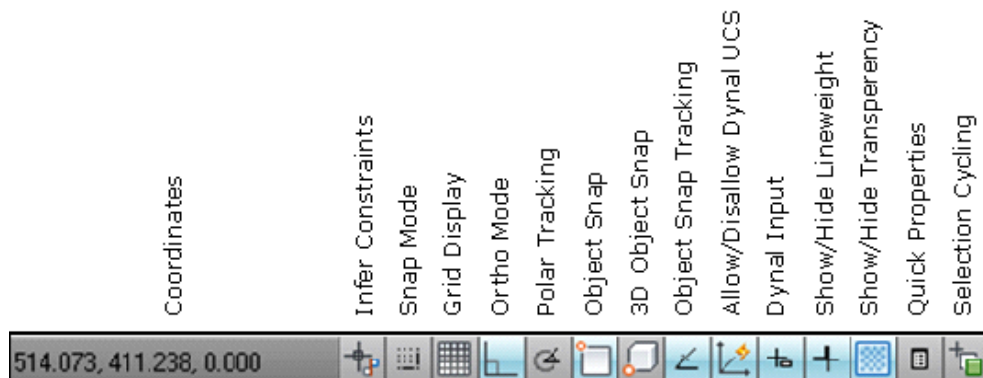
Coordinates:

The cursor coordinates readout displays the current X,Y,Z location of the cursor in the drawing area, with respect to the origin point (whose coordinates are 0,0,0). It is similar to having a GPS (Global Positioning System) device in the drawing.

If the coordinates in the lower-left corner of the screen are grayed out, then coordinate tracking is turned OFF and the coordinates will not change. The coordinates appear with dark lettering when the coordinates are turned ON and change when the cursor is moved about the drawing area.

Infer Constraints:
Constraints are used in parametric drawing to permanently position an entity of point to a corresponding point.

Snap, Grid, and Ortho:
The Snap, Grid and Ortho buttons control three of AutoCAD's tools for ensuring precision drawing and editing. **Snap** constrains the cursor to regularly spaced hot spots, enabling you to draw objects a fixed distance apart more easily. **Grid** displays a series of regularly spaced dots, which serve as a distance reference. **Ortho** constrains the cursor to horizontal or vertical relative movement.

Polar Tracking:
Polar tracking causes the cursor to prefer certain angles when you draw and edit objects. By default, the preferred angles are multiples of 90 degrees, but you can specify other angle increments, such as 45 or 30 degrees. Clicking the POLAR button toggles polar tracking on or off. Ortho and polar tracking are mutually exclusive — turning on one mode disables the other.

Object Snap and 3D Object Snap:
Object Snap is a tool used for ensuring accurate drawing and editing by locking onto the precise points of existing entities — for example, the endpoint of a line or the center of a circle.

Object Snap can be used in a *Running* mode where the individual Object Snaps are constantly turned on or in a *Temporary* mode by selecting the required Object Snap from the context menu; the temporary snap works for the selection of the one point only.

Object Snap Tracking:
Object Snap Tracking hunts in a more sophisticated way for points that are derived from object snap points.

Allow/Disallow Dynamic UCS:
Allow/Disallow Dynamic UCS – Dynamic UCS (User Co-ordinate System is used in 3D modes and will be covered in later, and more advanced units.

Dynamic Input:
Dynamic Input – Turns the dynamic input ON and OFF. Dynamic Input provides a command interface near the cursor to assist in focusing in the drafting area instead of having to read from the Command Line. When Dynamic Input is on, tooltips display information near the cursor that is dynamically updated as the cursor moves. When a command is active, the tooltips provide a place for user entry.
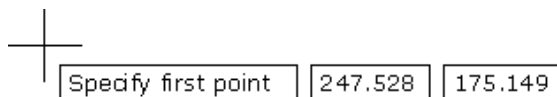

The data displayed in the tooltip area changes depending on the command and the information being input.

Show/Hide Lineweight:
Show or Hide Lineweight controls whether the display of the lineweights on the screen. The button does not control the lineweights appearing on plots which is controlled by a separate setting in the Plot dialog box.

As a drawing is zoomed in or out, the display of the lines will automatically adjust to display the thick, medium and thinner lines in proportion to the screen.

OFF

ON
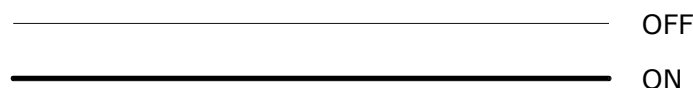
Quick Properties:

Turns the Quick Properties dialog box On and Off. Quick properties allows the operator to changes the properties (layer, colour, lineweight etc) of any entity on the current drawing.

Selection Cycling:

Selection Cycling assists when trying to select overlapping entities in a congested 2D or 3D drawing. When the Selection Cycling is turned On, a dialog box displaying all overlapping entities appears on the screen. As the cursor is passed over each object in the list, the relevant entity in the drawing is highlighted enabling the correct entity to be selected.

Tray Settings:

The Tray Settings line displays valuable information about the drawing statistics, modes and extents. The modes on the status bar can also be accessed using the appropriate Function key on the top of the keyboard.
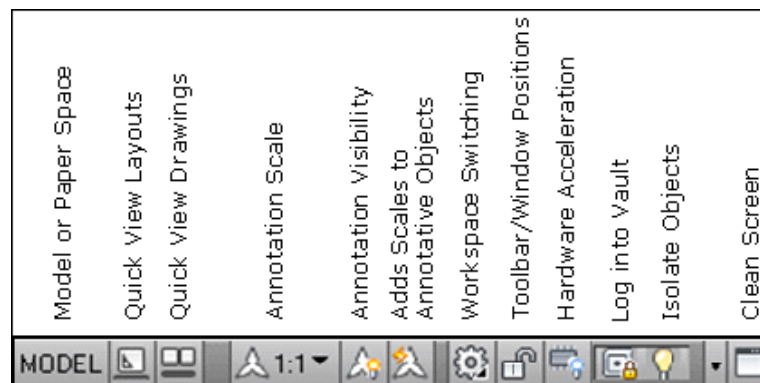
Model or Paper Space:

The drawing area is composed of overlapping tabbed areas labeled Model, Layout1, and Layout2 by default. The Model tab displays a part of the drawing called *model space,* where most of the drawing is created. Each of the remaining tabs displays a *paper space layout,* where a plottable view with a title block is created. A completed layout will include one or more *viewports*, which reveal some or all the objects in model space at a particular scale.

Quick View Layouts:

When the Quick View Layouts button is selected, the Layouts are displayed as thumbnails. Holding the Ctrl key and scrolling the mouse wheel dynamically changes the image tile size.

Quick View Drawings:

The Quick View Drawings button displays the currently opened drawings and their Layout preview in a dynamic view thumbnail tile. As with the Quick View Layout button, the Ctrl and mouse to change the size of the thumbnails.

Annotation Scale:

Annotation scale is a setting that is saved with model space, layout viewports, and model views. When annotative objects are added to the drawing, they support the current annotation scale and are scaled based on that scale setting and automatically displayed at the correct size in model space.

Annotation Visibility:

All annotative objects, or only those that support the current annotation scale can be displayed in model space or a layout viewport.

Adds Scale to Annotative Objects:
The Add Scale to Annotative Objects button

When an annotative object is created, it supports one annotation scale; the annotation scale that was current when the object was created. The annotative objects can be updated to support additional annotation scales.

Workspace Switching:
Using the Workspace Switching button allows the switching between the Ribbon, Toolbar, 3D Modelling, or other available display modes shown in the Pop-up menu.

Toolbar/Windows Positions:
The Toolbar/Windows button is used to lock the layout viewports so the scale canot be accidentally adjusted.

Log into Vault:
Autodesk Vault is a data management tool and helps design teams to track work in progress and maintain version control in multi-user environments allowing members to organize and reuse designs by consolidating product information and reducing the need to re-create designs from scratch. Access is available clicking the button to ON.

Isolate Objects:
The Isolate Objects button allows the user to control the display of objects by isolating or hiding a selection set and has nothing to do with layers. Objects to be isolated or hidden can be selected individually or using a window.

Clear Screen:
Selecting the Clean Screen button provides a larger view of the graphics area by turning everything OFF on the screen except for the status bar, menu bar, and the command line. Invoking the Clean Screen command again restores the screen to the previous settings.

Navigation Bar:
The Navigation bar assists in navigating around the drawing.

View Cube

Navigation Wheel

Pan

Zoom

Orbit

Show Motion

View Cube:
The View Cube is a clickable interface that provides a reference to the current orientation of the model and allows switching between standard and isometric views.

Navigation Wheel:
Provides access to the Full Navigation Wheel used when operating in the 3D mode and a smaller 2D version used in the 2D mode.

Pan:
Panning allows the operator to quickly move around the drawing area at the same magnification.

Zoom:
Provides access to a range of zooming tools through the drop-down menu.

Orbit:
Allows the 3D model to be viewed at any rotated angle or position.

Navigation Tools:
Navigation tools change the orientation and view of the model and will be covered separately in future lessons.

Show Motion:
Creates animated presentations.

Basic Commands:
Commands, common to all Windows programs are also found in AutoCAD on the Quick Access Menu and the Menu Browser; they include Open, New, Save, Print, View and Spelling and can be accessed by left clicking once on the applicable icon.

Open		Opens an existing AutoCAD drawing with an extension of *.dwg*.
New		Creates a new AutoCAD. New documents are created using a template or a blank format. A template has a prepared basic structure for a drawing and contains settings such as Layers, Dimensions and Text Styles, Drawing Size and Units.
Save		Saves a new document file by requesting the path and name of the file and automatically saves a named file to the specified folder with an extension of *.dwg*.
Plot		Prints the document to a specified printer or plotter.

Tutorial Exercise TUT1-1:
Access the AutoCAD program and create a new drawing using a template file called **A4BASIC.DWT** that is stored in the CAD Drafting Template folder on the college network drive.

Procedure:
1. Enter the AutoCAD program by clicking on the AutoCAD icon on the desktop.
2. Left click on the New drawing button in the Quick Access Menu.
3. Expand the Look in box by clicking the triangle .
4. Locate the drawing template called **A4BASIC** the template area.
5. Click **OPEN** at the bottom of the dialog box and the new drawing is created.

Ribbon or Toolbar Menus:
The decision to use Ribbon or Toolbar Menus will be determined by the operator's experience using computer technology; many long-term users will probably continue to use the Toolbar menus while new users should probably become accustomed to using the Ribbon menu system as most other Microsoft software.

The topics in this Student Resource Book will be delivered using the Ribbon menu as the majority of users will be new while the more experienced operators will be able to continue with the use of the toolbars.

Ribbon Menu:
The AutoCAD Ribbon (including the Application menuand Quick Access Toolbar) presents a user interface similar to the Microsoft Office programs. The ribbon provides easy access to tools through a collection of tabs and panels with each tab containing multiple

panels and the panels containing multiple command buttons. Some panels can be expanded to access additional tools by clicking the expand ▾ icon; clicking the ⬝ icon allows the operator to modify the styles for the options within the panel.

Of the 8-tabs displayed in the Ribbon menu, only the Home, Insert and Annotate tabs will be explained in this Unit.

The display of the Ribbon menus can be controlled using the Minimise ◼◼ button next to the Vault tab. Minimising options are Minimise to Tabs, Minimise to Panel Titles, or Minimise to Panel Buttons.

Home Tab:

The Home tab contains the most frequently used commands within the software. Basic object and drawing tools can be found here, as well as frequently used commands like modification tools, layers, and basic annotation. The Utilities and Clipboard panels and some of the individual commands contained in the remaining panels will not be included in this unit. The image of the Home tab has been split into 2-separate images for clarity.
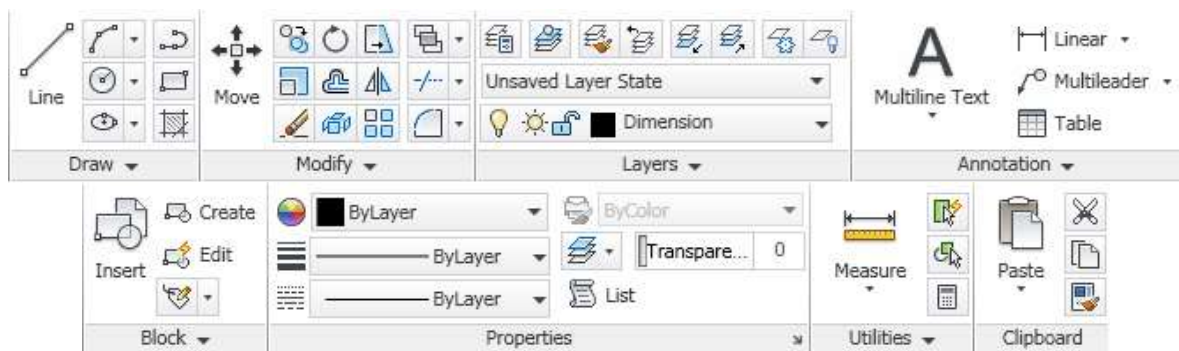

Figure 1.3 – Home Tab

Draw – Contains the main tools for creating the entities in a drawing. Commands covered in this unit include Lines, Arcs, Circles, Ellipses, Rectangles, Polylines, Polygons, Splines and Hatching.

Modify – Includes the commands for modifying the views, and entities. Commands include Erase, Trim, Extend, Copy, Move Stretch, Scale, Offset, Mirror, Fillet, Chamfer, Array (Rectangular and Polar), Break, Lengthen and Editing Hatch.

Layers – Contain the commands needed to work with various layers. Commands include Layer and Layer Properties (Visible, Freeze, Lock, Colour, Construction and Lineweight).

Annotation - Includes the commands for inserting text, leaders, and dimensions.

Block – Blocks are groups of entities (e.g. symbols and drawing sheets) that can be inserted to a drawing to reduce drawing time.

Properties – Layers are used to identify different types of lines, notes and dimensions on a drawing. The visibility and editing of various layers can be turned ON and OFF as required.

Utilities – Provides a series of commands to find the length, area, volume and other information of entities or shapes.

Clipboard – Can be used to copy and paste entities around the drawing.

Insert Tab:

The Insert tab is used to add and create various types of blocks in a drawing. During this unit only the Insert command in the Block panel will be used. The image of the Insert tab has been split into 2-separate images for clarity.
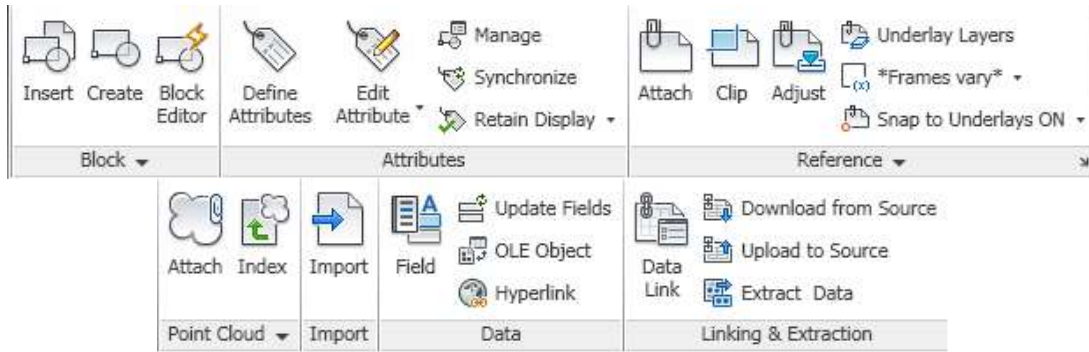
Figure 1.4 – Insert Tab

Block – Creates and inserts blocks such as symbols and drawing sheets onto the drawing.

Attributes – Inserts blocks of lines and text into a drawing.

Reference – Links a block in the drawing with a master drawing so the most current inserted drawing is displayed.

Point Cloud – Point clouds are used in 3D work and consist of a set of points created by 3D scanners.

Import – Imports files of different formats (.FBX, .WMF, .SAT, .3DS and .DGN) into the current drawing.

Data – Inserts fields and OLE objects into the drawing and creates hyperlinks.

Linking and Extraction – Links and extracts data to and from the drawing.

Annotate Tab:

The Annotate tab contains the commands used to dimension and add text to the drawing as well as commands to create multi-leaders and tables. The scale of the text and dimensions is adjusted with the annotation scales. During this unit only the Text, Dimensions and Leaders panels will be used.
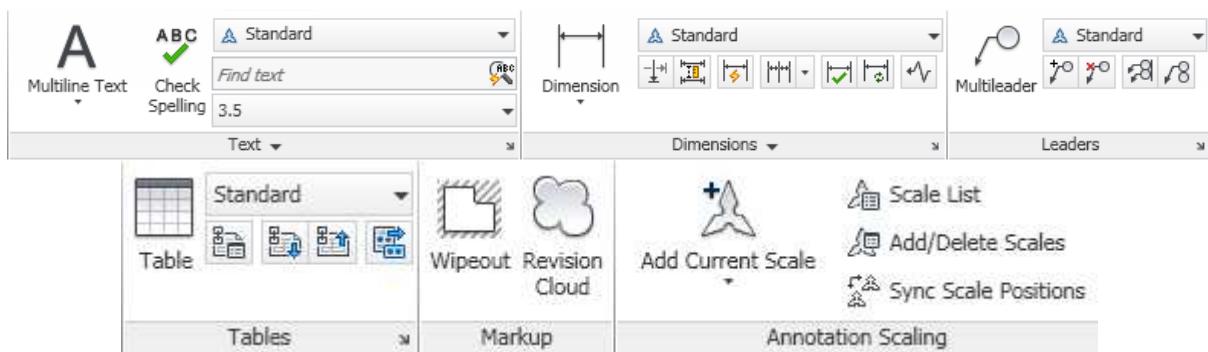

Figure 1.5 – Annotate Tab

Text – Multiple lines of text can be added to the drawing using the text command. Options within the panel allow existing text styles to be modified or new text styles created.

Dimensions – Dimensions of various styles can be applied to the drawing. Existing dimension styles can be modified and new dimension styles created.

Leaders – Places notes on the drawing and connects to the specific detail with arrows. Existing leader styles can be modified and new leaders created.

Tables – Creates and places tables on a drawing plus uploads and connects data.

Markup – Allows specified areas of the drawing to be hidden behind a white area; features that have been modified can be indicated with the Revision Cloud button.

Annotation Scaling – Modifies and applies annotation scales to entities.

Dynamic Input:

Dynamic Input provides a command interface near the cursor to assist in keeping the operator's focus in the drawing area. When Dynamic Input is on, tooltips display information near the cursor that is dynamically updated as the cursor moves. When a command is active, the tooltips provide a place for user entry. After a value is types in an input field and the Enter key pressed, the field then displays a lock icon, and the cursor is constrained by the entered value. A value can then be entered for the second input field. Alternately, if a value is typed and the Enter key pressed, the second input field is ignored and the value is interpreted as direct distance entry.

Dynamic Input is not designed to replace the command window. The command window can be hidden to increase the size of the screen area for drawing, but will need to be displayed for some operations. The F2 key is used to hide and display command prompts and error messages as needed.   Alternately, the command window can be undocked and Auto-hide used to roll open or roll up the window.

Turn Dynamic Input On & Off:

Click the Dynamic Input button ╬ on the status bar to turn the dynamic input on and off. The Dynamic Input can also be turned off temporarily by pressing the F12 key. Dynamic Input has three components: pointer input, dimensional input, and dynamic prompts.

The Settings to control what is displayed by each component when dynamic input is on is accessed by right-clicking on the Dynamic Input button ╬ on the status bar.

Pointer Input:

When pointer input is on and a command is active, the location of the crosshairs is displayed as coordinates in a tooltip near the cursor. Coordinate values can be entered in the tooltip instead of on the command line. The default for second and subsequent points is relative polar coordinates (relative Cartesian for RECTANG). There is no need to type the "at" sign (@).   If absolute coordinates are to be used, the number sign (#) is used as a prefix.   For example, to move an object to the origin, for the second point prompt, enter ***#0,0.***
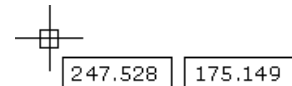
Dimensional Input:

When dimensional input is on, the tooltips display distance and angle values when a command prompts for a second point. The values in the dimensional tooltips change as the cursor is moved.   Press TAB to move to the value to be changed. Dimensional input is available for ARC, CIRCLE, ELLIPSE, LINE, and PLINE.
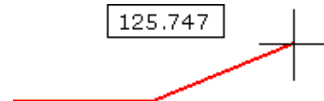

When grips are used to edit an object, the dimensional input tooltips can display the following information:
- Original length
- A length that updates as you move the grip
- The change in the length
- Angle
- The change in the angle as you move the grip
- The radius of an arc

Dynamic Prompts:

When dynamic prompts are on, prompts are displayed in a tooltip near the cursor; responses can be entered in the tooltip instead of on the command line. Press the DOWN ARROW key to view and select options.   Press the UP ARROW key to display recent input.
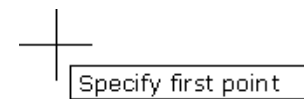
Ortho Mode:

The Ortho Mode restricts the cursor movements to horizontal and vertical for convenience and precision when creating and modifying objects. As objects are created or moved, the Ortho mode is used to restrict the cursor to the horizontal or vertical axis; as the cursor is moved, the rubber-band line follows the horizontal or vertical axis, along whichever is nearest to the cursor.   The orientation of the current user coordinate system (UCS) determines the horizontal and vertical directions. In 3D views, Ortho mode additionally restricts the cursor to the up and down directions, in which case, the tooltip displays a +Z or -Z for the angle.

Ortho can be turned ON and OFF at any time during drawing and editing. Ortho is ignored when coordinates are entered, or an object snap specified. To turn Ortho ON and OFF temporarily, hold down the temporary override key, SHIFT. While the temporary override key is used, the direct distance entry method is not available.

The Ortho mode is turned ON and OFF by clicking the Ortho ⌐ icon on the Status Bar at the bottom of the graphics area, or, pressing the F8 function key on the keyboard.

2D or 3D:

A 2D CAD system lets the user work only in the X and Y axis - basically up and down, left and right. Objects can be made to look objects 3D, similar to how it would be drawn on paper using various drafting tools (set squares, curved templates, etc.); this type of CAD system can be relatively less expensive than its 3D counterpart, and is useful for drawings showing floor plans, elevations, and detail drawings of objects such as top, front, right side views.

A 3D CAD system lets the operator work in the X, Y, and Z-axis. It is similar to creating and working with actual material (like creating a sculpture). If a cube is created in 3D and is rotated, it will still look like a cube.   High end 3D CAD systems can become expensive depending on the level of 3D resources required.

3D capabilities are available within the standard AutoCAD and other CAD software however the operator is restricted to wireframe and simple solid modelling.   In wireframe, objects can be created in 3D mode, line by line, and then surfaces applied between the lines or faces; this type of drawing leaves the object hollow and with no density. The solid model component of AutoCAD and other similar programs allows basic shapes to be joined (union), taken away (subtract) or interconnected (intersect).

The higher end programs are specifically designed for 3D operation and can indicate whether components have sufficient designed strength, or may collide with other components during operation; the software also has the ability to animate assemblies. The physical properties (material, mass etc.) of individual or multiple components can be changed as required.   An assembly or associated parts and detail drawings are automatically updated to reflect any modifications to the shape or dimensions of any component.